



Thymidine/Alcohol/Surfactant/Water System Studies by Refractive Index and UV-Vis Spectroscopy

Ramírez H, Güzeloğlu A and Wilczura-Wachnik H*

Faculty of Chemistry, University of Warsaw, Poland

*Corresponding author: Wilczura-Wachnik H, Faculty of Chemistry, University of Warsaw, Poland; E-mail: wilczura@chem.uw.edu.pl

Abstract

The subset of the micro-emulsions set, the reverse micelles, have been of great interest for the nanotechnology in cosmetic, food and pharmaceutical industries. The systems of surfactants in nonpolar solvents show the formation of reverse micelles that can be used as carriers. A critical parameter of its formation, the Critical Micelle Concentration (CMC), is evaluated by the refractive index and the UV-Vis spectroscopic technique for the system AOT/n-decanol/water in the thymidine presence. The obtained data showed that the sensitivity of the refractive index technique was comparable with UV-Vis, although at very low concentrations was not enough sensitive. Obtained results with UV-Vis technique showed that with water concentration increasing the critical micelle concentration decreases.

Keywords: Thymidine; Reverse micelles; Refractive index; UV-Vis spectroscopy

Introduction & Definition

A common process in nature is the self-assembly of atoms or molecules to form patterns or structures without external interference. This characteristic has been used in the nanotechnology industry. The term surfactant has been used as a shortcut for the surface active agent to name the amphiphilic molecules with a polar head and nonpolar chain. Its characteristics and size are affected principally by the surfactant molecular structure, composition and temperature but also other parameters such as concentration, salinity and pH are known to control their morphology [1].

Reverse micelles are a subset of structures in the micro-emulsions set formed when an amphiphilic molecule delineates a Nano scale droplet of the aqueous phase from a nonpolar medium by coating the surface of an isolated water droplet in solution, as shown in (Figure 1). The primary function of the surfactant is to reduce the surface tension between the other phases and promote an increase in the total area of the interface also to form 3D morphologies in aqueous or non-aqueous systems [2].

The reverse micelles are formed when the concentration of the surfactant is higher than the CMC parameter, which is the minimum concentration of surfactant needed. It is reported that the surfactant systems exhibit an exponential decrease in the CMC value in accordance, at constant temperature, with the size of the hydrophobic phase, for ionic and non-ionic surfactants [3]. In the last decade reverse micelles have been of big interest because of the diverse applications suitable for them, such as it was mentioned in food, cosmetic and pharmaceutical formulations in the nanotechnology industry.

Reverse micelle shape and size has been characterized through a range of techniques such as small angle neutron scattering (SANS), small angle X-ray scattering (SAXS), dynamic and static light scattering [4].

It is known the size of the micelles formed depend on the amount of water presence in the system. WO (sometimes also referred as R) is defined as the molar ratio of water to surfactant concentrations. (Equation 1) The solvation degree of the hosted molecule and the encapsulation efficiency parameters are also affected by the ratio value [5].

Received date: 20 August 2020; **Accepted date:** 24 August 2020; **Published date:** 28 August 2020

Citation: Ramírez H, Güzeloğlu A, Wilczura Wachnik H (2020). Thymidine/Alcohol/Surfactant/Water System Studies by Refractive Index and UV-Vis Spectroscopy. SunText Rev Pharm Sci 1(1): 101.

DOI: <https://doi.org/10.51737/2766-5232.2020.001>

Copyright: © 2020 Ramírez H, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

$$w_0 = \frac{[H_2O]}{[surfactant]} \quad (1)$$

Surfactants can be divided by dependence of their hydrophilic group, those with charge (cationic and anionic), neutral but polar (non-ionic) or zwitter ionic. Sodium Bis (2-ethylhexyl) sulfosuccinate (AOT) is an anionic surfactant widely explored because of its ability for normal and reverse micelle formation (Figure 2).

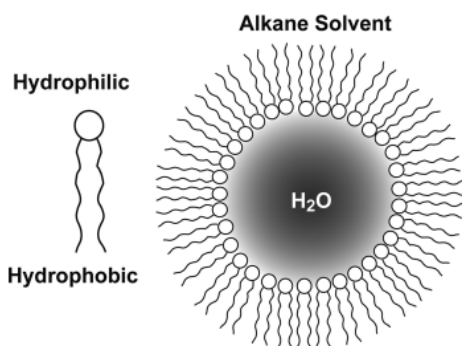


Figure 1: Schema of reverse micelles [3].

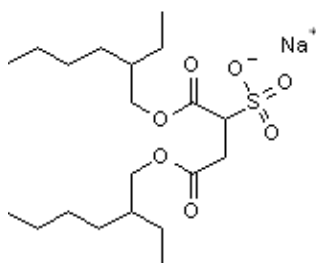


Figure 2: Chemical structure for AOT.

AOT reverse micelle systems are founded commonly in the literature, its structural properties allows it to form the micelle without the presence of a co-surfactant.

Thymidine (Figure 3) is a nucleoside consisting of one thymine molecule linked to a D-deoxyribose sugar molecule. It is the DNA nucleoside T, which pairs with Deoxyadenosine A in double stranded DNA. It is used to synchronize the cells in the S phase. The modified analogs of thymidine are used in treatments of some diseases (HIV) or some procedures in the biochemical research. Different techniques can be used in the study of CMC surfactants solutions, i.e. refractive index, dynamic light scattering, calorimetry and UV-Vis spectroscopy.

The UV-Vis spectroscopy is based on the Lambert-Beer II law which relates the concentration of a sample with the absorbance of a light beam that pass through the sample as can be seen in the equation 2.

$$A = \varepsilon * l * c \quad (2)$$

Where A is the absorbance, ε is the molar absorptivity [$\text{cm}^{-1}\text{mol}^{-1}$], l is the length path (cm) and c is the concentration of the surfactant solution [mol/L].

The refractive index technique measures the bending of a wave when it enters a medium where its speed is different, because of the change in the density of both mediums.

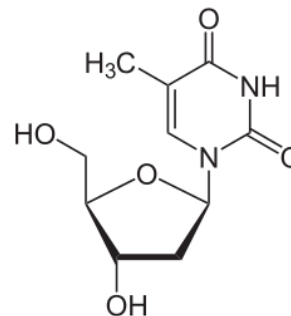


Figure 3: Chemical structure of thymidine.

In the present work the aims were the CMC detection for surfactant solutions using refractive index, and UV-Vis techniques for the system thymidine/alcohol/surfactant/water. The selected alcohol was n-decanol and the surfactant was sodium dioctyl sulfosuccinate (AOT).

The influence of thymidine and water on CMC of AOT in decanol has been studied.

Materials and Methods

The substances used in the experiment procedure were dioctyl sodium sulfosuccinate (AOT Aldrich, 98%), n-decanol (Fluka AG, 98%), thymidine chromatographically homogeneous (BDH, >98%), and bi-distilled water. All the substances were used without any further treatment or purification. All UV-Vis measurements were carried in a quartz cell using spectrophotometer Varian Cary WinUV at room temperature. CMC was detected trough refractive index measurements using Abbe refractometer. As additional equipment in solutions preparation were used an IKA Vortex Genius 3, an analytical balance Radwag WAS 160/X, an ultrasonic bath Ultron and a Wigo magnetic stirrer.

Solutions preparation and measurement

AOT solutions: The suitability of the AOT as surfactant in presence of thymidine in n-decanol solutions was checked by the UV-Vis spectroscopy technique. The bands were not overlapping and the selected wavelength for the further measurements was 267 nm. Then, the solutions of AOT in n-decanol were prepared as the (Figure 4) shows. In the case of AOT solutions, the effect of the added water was also tested. The amount of water was calculated based according to the relation $R = [H_2O]/[AOT]$ with $R=10$ and 20 as is shown in (Figure 5). All prepared solutions both from gravimetric or dilution method were kept on the stirrer for at least 3 days to get completely homogeneous and transparent solutions. Next, solutions were used in measurements.

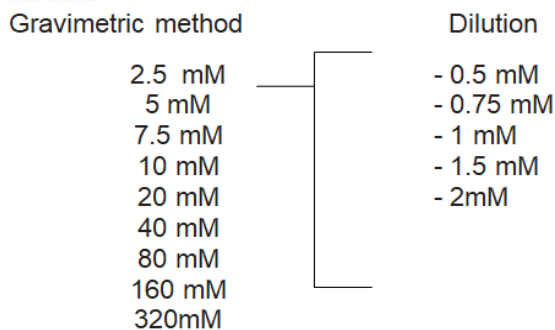


Figure 4: Schema of the AOT solutions in *n*-decanol preparation.

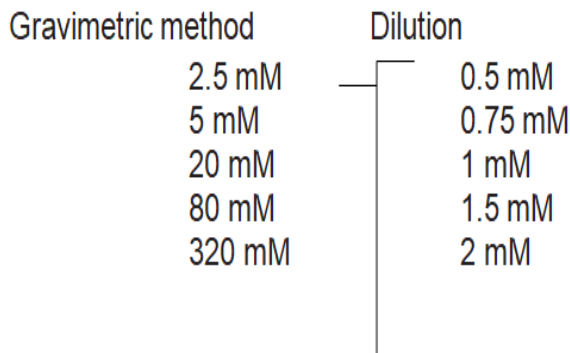


Figure 5: Schema of the AOT solutions in *n*-decanol with water preparation.

Measurement with UV-Vis and refractive index

For all the UV-Vis measurements thymidine absorption spectra were recorded in the λ range 190-400 nm. As described in the above section, the measurements were done in the following way: first for surfactant/*n*-decanol solution or surfactant/*n*-decanol/water baseline was recorded. Next to the surfactant solution, the thymidine solution was added, stirred a few minutes and the spectrum of the solution was recorded. All UV-Vis measurements were done at room temperature. It was used 2.7 ml of AOT solution for the base line registration, and 0.3 ml of 0.58 mM thymidine to complete a total volume of 3 ml of solution measured with a final concentration of 0.058 mM for the thymidine. The max absorbance for thymidine was found at 267 nm. Methodology for the refractive index (RI) measurements was the following: first RI for the pure solvent was measured, next surfactant solutions with different concentrations. RI measurements were done at room temperature too.

Results and Discussion

For the AOT system, the CMC values were obtain analytically from the UV-Vis data. These values can be also read from the graph (Figure 6) by the inflexion point. Moreover, on the Figure 6 is shown the influence of water on the CMC value.

From the Figure 6 it is easy to see the pattern that the inflexion point moves through the left (less concentration of AOT) with water amount increasing. It is worth to note that for the water ratio $R=0$ the solution of 320 mM AOT was not completely dissolved, that is why this point doesn't appear on the graph. From these UV-Vis experiments the critical micelle concentration obtained is shown on the (Table 1).

Table 1: Critical micelle concentration values for the system thymidine/*n*-decanol/AOT/water.

R= [water]/[AOT]	CMC (mM)	Wavelength (nm)
0	75	267
10	62	267
20	16	267

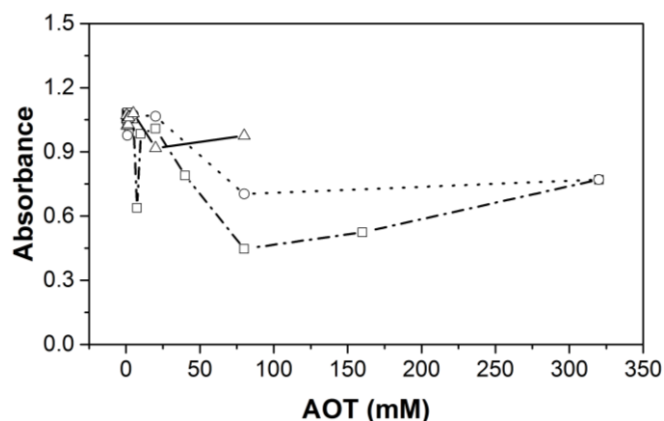


Figure 6: Results for the thymidine/*n*-decanol/AOT/water system by UV-Vis spectroscopy obtained. Water ratio $R=0$, squares; $R=10$, circles; $R=20$, triangles.

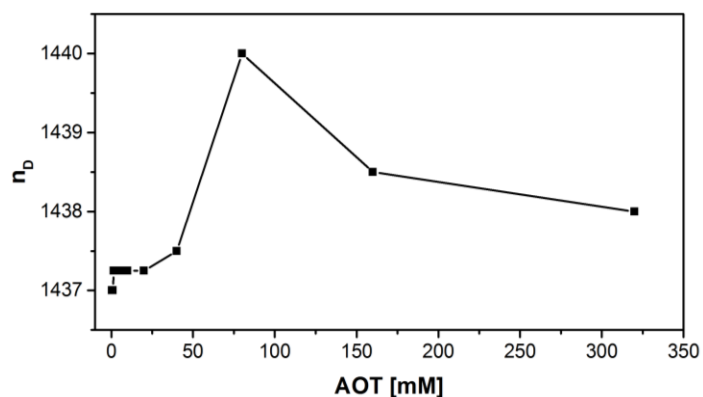


Figure 7: Refractive index measurements for the system thymidine/*n*-decanol/AOT/ with $R=0$. The line is illustrative, not fitting was done.

It can be easily see that as the water ratio parameter (R) increases, the critical micelle concentration decreases. It means that the water presence in the solution accelerate the micelle formation. The refractive index technique was also used to detect the CMC parameter. This technique was only used for the system without water ($R=0$). The results obtained can be seen on the (Figure 7).



The value obtained from the inflexion point, referred as the critical micelle concentration is around 75mM for the system AOT/n-decanol/thymidine with $R=0$. As we can see, the difference in values for the CMC between the refractive index and the UV-Vis spectroscopy for the same ratio water ($R=0$) is not significant.

Conclusion

The critical micellar concentration for AOT in n-decanol solution with thymidine presence was evaluated by refractive index and UV-Vis spectroscopy. The obtained data showed that the sensitivity of the refractive index technique was comparable with UV-Vis although at very low concentrations was not enough sensitive. Obtained results with UV-Vis technique showed that with water concentration increasing the critical micelle concentration decreases. This means that the presence of water helps in the process to the formation of the reverse micelles.

Declaration of Interest

The author has no relevant affiliations or financial involvement with a financial interest in or financial with the subject matter or materials discussed in the manuscript.

Conflicts of Interest

There is no conflict of interest.

References

1. Shrestha L, Shrestha R, Aramaki K. Demonstration of solvent-induced one-dimensional nonionic reverse micelle growth. *J Phys Chem Lett.* 2013; 4: 2585-2590.
2. Brown D, Clarke J. Molecular Dynamics Simulation of a Model Reverse Micelle. *J Phys Chem.* 1988; 92: 2881-2888.
3. García F, Mackie A. Low critical micelle concentration discrepancy between theory and experiment. *J Phys Chem Lett.* 2014; 5: 2027-2032.
4. Correa N, Silber J, Riter R. Nonaqueous polar solvents in reverse micelle systems. *Chem Rev.* 2012; 112: 4569-4602.
5. Van Horn W, Ogilvie M, Flynn P. Reverse Micelle encapsulation as a model for intracellular crowding. *J Am Chem Soc.* 2009; 131: 8030-8039.